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TUNNELS AND TUNNELLING.

Modern Tunnel Practice. By D. McNeely Stauffer. Pp. viii + 314. (London: Archibald Constable and Co., Ltd., 1906.) Price 21s. net.

THE author of this book is to be congratulated both upon having produced what will prove to be a useful book of reference for engineers engaged in the arduous work of tunnelling, and also upon the fair and impartial manner in which he writes. He has given credit to those men whose names are associated with certain great improvements, and has not attempted, as is sometimes unfortunately the case, to claim inventions for his countrymen which rightfully belong to English, Italian or other nationalities.

Mr. Stauffer is an American engineer in New York, but he is also enrolled as a member of our Institution of Civil Engineers of London, and it is evident that he has had considerable and practical experience of the difficulties of tunnelling.

Naturally tunnels are things to be avoided as being both costly and difficult, but for penetrating mountains, crossing under rivers and arms of the sea, or for traversing our great towns and cities, they are indispensable. There is, however, one well-known case of a tunnel in South America in which the engineers deliberately ran their railway into a mountain in order that their country should not retain the notoriety, undesired by them, of not possessing a single work of the kind, and over the portal of that tunnel is marked in large letters, "This is the first tunnel in the country."

The illustrations are good and brought down to a recent date, but they unfortunately suffer from the one defect that the dimensions and notes of reference are almost too small to be read except with the aid of a magnifying-glass; it is a recognised principle that drawings which are to be reduced for publication in the leaves of a book should have all the writing and figures several times the usual size, so as to be easily legible when reduced.

The chapter on surveying for tunnels contains the latest practice, and will be useful to all students and young engineers. The author describes how a ray of light is now used in many cases in place of wires, but where the latter are still employed the inconvenience resulting from their acting as long pendulums is overcome by suspending the plummets in buckets of water; tar, with its greater viscosity, is, however, more certain in its action, but has the drawback of being easily floated out by water falling down the shaft.

The use of explosives is gone into very fully, many of the various kinds being described, with rules for their handling and thawing in cold weather; the general principles of blasting and the position and depth of bore-holes are carefully explained.

It is found by experience that when driving a heading or gallery through hard material, more rapid progress is made if a wedge-shaped mass of rock be blown out first, in the centre of the work, as by so

doing the excavation round the margin of the tunnel section is more easily removed to a true line. This is effected by making the centre holes converge to a point, and charging them in such a manner, by shortening the fuse, that their charges will be fired a few seconds earlier than those in the remaining holes. Useful hints are given as to the precautionary measures to be taken in case of a misfire, when a charged hole has to be bored out.

The effects upon the engineers and workmen from the products of combustion of the explosives are referred to, and instructions are given as to remedies, but the principle of ample ventilation right up to the very face of the work cannot be too strongly insisted upon. If large volumes of fresh air are provided for the men in the most advanced working, no danger of asphyxia is to be feared.

The introduction of high explosives, powerful drills, and ample machinery has reduced the necessity for a large number of shafts, and work is now often conducted only from the two portals. The author discusses from a practical point of view the size and shape of shafts when required, and is of opinion that those of rectangular form are preferable to either square or circular ones. Doubtless there is much to be said in favour of his views, but if water be encountered in a shaft and has to be "tubbed out," the circular is the only permissible form. As regards the actual sinking through water-bearing strata, compressed air cannot be made available under a greater "head" than 100 feet. Pumping can be resorted to, as is usually the case, or the "Kind-Chandron" method of sinking, as was done at Whitburn, whilst the more modern system of freezing has been tried with success recently in one or more of the collieries in Durham.

It is, however, costly, and has its own inherent dangers which must be provided against; for instance, a case recently occurred in which the frozen material gave way under the hydrostatic head of the water behind it, and blew in the side of the shaft.

The various methods of tunnelling known as the English, the Belgian, the German, and the Austrian systems are described, and it is satisfactory to note that the Americans adopted the first of these in several of their important tunnels. The use of steel needles in a London tunnel under houses is referred to, but notwithstanding every possible care and precaution, some injury was done to the property; now, however, by the adoption of the shield, this is reduced to a minimum.

It is satisfactory to observe that the author gives the credit to the late Mr. Greathead of his shield, for although he was not the actual inventor, yet it was he who so modified and introduced it into practical work that it has been universally adopted by the engineering profession as the solution of much of the difficulty encountered in tunnelling. In like manner the name of Signor Saccardo is given as having invented the admirable system of ventilation with which his name is connected, although in more than one case in America his proposals have been adopted without his name even being mentioned.

The important tunnels in Paris, Budapest, Boston,

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and New York are fully discussed, and one of the most instructive chapters is devoted to the Simplon Tunnel with its approaches on the Italian side between Domo d'Ossola and Iselle. The arrangements for the men, the power installation, ventilation, air refrigeration, illumination, drainage, workshops, buildings, as also the transportation service, are dealt with in such a manner as cannot fail to be useful to readers, and when it is remembered that notwithstanding the innumerable difficulties which were encountered from hard rock, hot springs, and crushing timbers, an annual progress was attained of one mile at each face, a record has been established which it will be very hard to beat. Subsequent to the date at which the book was written, it was found that in the bad ground at 4.4 km. from Iselle steel girders and timbers could not contend with the load they were called upon to carry, and that steel girders with cement concrete alone enabled the work to be proceeded with.

Much information is given as to the ventilation of tunnels, and if only from a public point of view this is satisfactory as indicating the greater amount of attention which is now being devoted to this branch of scientific engineering.

The use of compressed air in caissons, which was first applied at Rochester Bridge by Sir Charles Fox, is gone into at length, and in connection with the illness known as caisson disease it can be mentioned that the admirable system of re-compression in cases of men being affected was first proposed and carried out by Mr. Moir.

A very important part of the book describes the extended use which is being made throughout the world of concrete in cement. Within the last ten years this has come into favour and is being applied to works of all kinds. Even subaqueous tunnels, such as that at Boston, are being wholly constructed of concrete, and whereas a few years ago the material was regarded with suspicion, to-day it is being loaded to the extent of 15 tons per square foot. How to render concrete air-tight and waterproof is a problem with which the author deals.

In the appendix is given a useful glossary of terms used in tunnelling, and the book is rendered complete by a fairly extended index of contents.

ANCIENT ASTRONOMY.

Astronomy in the Old Testament. By Prof. G. Schiaparelli. Authorised English translation, with many corrections and additions by the author. Pp. viii+178. (Oxford: Clarendon Press, 1905.) Price 3s. 6d. net.

Researches into the Origin of the Primitive Constellations of the Greeks, Phœnicians, and Babylonians. Vol. ii. By Robert Brown, jun. Pp. xx+261. (London: Williams and Norgate, 1900.) Price 10s. 6d.

WE have in these two books works of very different scientific value. Prof. Schiaparelli's little book is that of an expert astronomer who has also a remarkable knowledge of the archæological

evidence as to the early history of astronomy in the East. This knowledge he uses with telling effect, bringing out his points in an orderly, marshalled, logical, and therefore convincing way. He is moderate and sensible in his deductions also, and never allows himself to be carried away by that deplorable impulse to wild philological comparison and identification which has been the curse of work of this kind hitherto. He has in his English edition also had the benefit of the collaboration of the sanest and most trustworthy critics of the Old Testament, Dr. Driver and Mr. Cowley to wit, so that the reader may rest assured that in reading the book he is not groping darkly among Cheyenean cryptograms, nor need he fear that he will be haunted by the unquiet spirit of Jerahmeel. Neither the ubiquitous "Jerahmeel" nor the elusive "Musri" (see NATURE, June 26, 1902) have a place in this eminently sane and work-a-day volume, which both archæologists and astronomers will find useful. The archæologists, indeed, would only be too grateful if the astronomers would help them more than they do. The mysteries of Mahler, for instance; no unastronomical archæologist quite knows whether they are scientific gospel or not. An instance of archæological ignorance of astronomy is given on p. 68—Arcturus confounded with Arctos, and said to be a star in the Bear.

Prof. Schiaparelli gives us a very lucid introduction, followed by a series of chapters on the general cosmology of the Old Testament, the stars and constellations, the doubtful *Mazzoroth* (perhaps the two phases of Venus), the arrangement of months, days, &c., among the early Hebrews. All is most interestingly expressed, and the archæological and historical references are most valuable. The connection of the Jewish star-lore with that of the Babylonians is carefully but moderately brought out. A serious defect in the book is the lack of an index. The translator or publishers undoubtedly deserve blame for not having had one compiled. No doubt French or Italian writers do not habitually make indices to their books. That is their defect; in England the reader wants indices, and the fact ought not to have been forgotten in this case.

We wish we could praise so highly Mr. Brown's "Primitive Constellations," as, to judge from his introduction, he is very sensitive to former criticisms. But honestly we cannot. The author of the "Great Dionysiak Myth" used to be hag-ridden by philological speculations of the kind which were fashionable in the days of Max Müller, Gladstone, and Sir George Cox, but have been recognised to be bad archæology these twenty years past. Of this we are bound to say we do not see so much in the present volume, and are glad of it, but at the same time we regret that Mr. Brown cannot bring himself to abandon his foolish explanation of the name Amalthea as the Assyrian *Ammâ*, "mother" + *l* (which we suppose is the Arabic *el*) + the Greek *θεῖα*; here you have it, Amalthea, "the divine mother" (!) Mr. Brown is still unable to perceive the absurdity of this. The learned author also used to be a victim of the Greek transliteration fad of Gladstone and